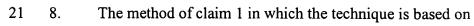
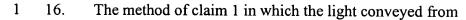
CLAIMS

	4	4 .4 4	
		A method	comprising
L	1.	A IIICUIOU	COMMONSTREE

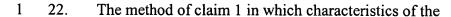
- 2 conveying light from a moving light source on the writing
- 3 instrument as an indication of the location and path of the writing
- 4 instrument on a two dimensional writing surface,
- 5 sensing the light at two or more sensors and generating a
- 6 sequence of signals representative of the sensed light, and
- 7 applying a technique to increase the stability of subpixel
- 8 reading.
- 9 2. The method of claim 1 in which the technique is based on
- 10 optics.
- 11 3. The method of claim 1 in which the optics are configured
- 12 to enhance the uniformity of signal response of the sensors.
- 13 4. The method of claim 3 in which the lens comprises a
- 14 spherical lens.
- 15 5. The method of claim 3 in which the lens comprises an
- 16 aspheric lens.
- 17 (6) The method of claim 3 in which the sensors comprise
- arrays of sensitive pixel elements.
- 19 7. The method of claim 3 in which the sensors comprise
- analog sensors.



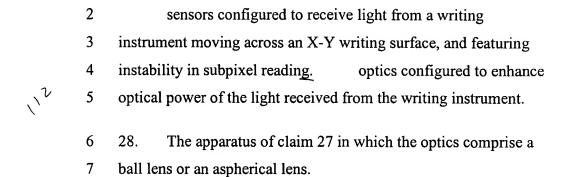
- 22 algorithmic processing of the generated signals.
- 23 9. The method of claim 8 in which the algorithmic processing
- 24 comprises mapping the signal response of the sensors based on
- 25 parameters associated with the writing instrument.
- 26 10. The method of claim 8 in which the technique is also based
- 27 on optics.
- 28 (11.) The method of claim 8 in which the sensors comprise
- 29 arrays of sensitive pixel elements.
- 30 12. The method of claim 1 in which the technique is
- 31 implemented in digital hardware.
- 32 13. The method of claim 1 in which the technique is
- implemented in analog circuitry.
- 34 (14.) The method of claim 1 in which the technique comprises an
- 35 algorithmic technique that also reduces the effect of variations of
- the light intensity based on other than dimensional effects.
- 37 15. The method of claim 1 in which
- 38 the sensors comprise pixel arrays,
- 39 the signals are grouped in frames, and
- 40 the signal processing technique comprises processing of
- 41 multiple frames to cancel noise.



- 2 the moving writing instrument is modulated at a frequency related
- 3 to the rate at which the signals are generated by the sensors.
- 1 17. The method of claim 1 in which
- 2 the light conveyed from the writing instrument is
- 3 modulated at a frequency, and
- 4 the sensor signals are chopped at the frequency of
- 5 modulation.
- 1 18. The method of claim 17 in which opposite gains are applied
- 2 to each of the chopped signals depending on the on or off state of
- 3 the light conveyed from the writing instrument that corresponds to
- 4 the signals.
- 1 19. The method of claim 17 in which the frame rate is varied.
- 1 20. The method of claim 18 in which the chopped signals are
- 2 integrated over time.
- 1 21. The method of claim 1 in which
- 2 the light conveyed from the writing instrument includes a
- 3 strong short pulse imposed on the modulation frequency, and
- 4 a phase lock loop determines the modulation frequency
- 5 from the sensor signals, and
- 6 the sensor signal is sampled at the times triggered by the
- 7 phase lock loop during the duration of the strong short pulse.

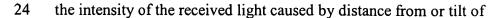


- 2 conveyed light are used for synchronization between the writing
- 3 instrument and the sensors.
- 1 23. The method of claim 1 in which the conveyed light
- 2 includes periods of lower frequency modulation and bursts of
- 3 higher frequency modulation, and the sensor signal associated with
- 4 the higher frequency bursts is used to lock onto a modulation
- 5 clock.
- 1 24. A method comprising
- 2 conveying light from a moving writing instrument in a
- 3 time-changing pattern of directions,
- 4 sensing the light at two or more sensors located at two or
- 5 more different locations spaced from the writing instrument, and
- 6 determining the location of the writing instrument by
- 7 detecting a phase difference between signals measured at the two
- 8 or more sensors.
- 1 25. The method of claim 24 in which the time-changing pattern
- 2 of directions includes a rotating pattern with respect to an X-Y
- 3 plane on which the writing instrument is moving.
- 1 26. The method of claim 25 in which the signal radiated in the
- 2 positive X direction is in phase quadrature to the signal radiated in
- 3 the Y direction.
- 1 27. Apparatus comprising



 \sim

- 8 (29.) The apparatus of claim 27 in which the optics include a
- 9 single spherical lens and the lens and the corresponding sensor are
- 10 together configured to enhance the optical power of light received
- at large angles or longer distances or at disadvantageous positions
- 12 of the writing instrument.
- 13 30. The apparatus of claim 27 in which the optics include a
- special lens configured to enhance optical power of the light
- received from a location on the X-Y surface that is beyond a
- 16 predetermined position.
- 17 31. The apparatus of claim 27 in which the optics include two
- 18 cylindrical lenses, one nearer the sensor to project light
- horizontally onto sensor, and the other positioned to collect light in
- 20 the Z-axis dimension, the other lens having a body that is bent
- 21 around the first lens.
- 22 32. The apparatus of claim 27 also including algorithmic
- processes that enhance the immunity of the signals to variations in

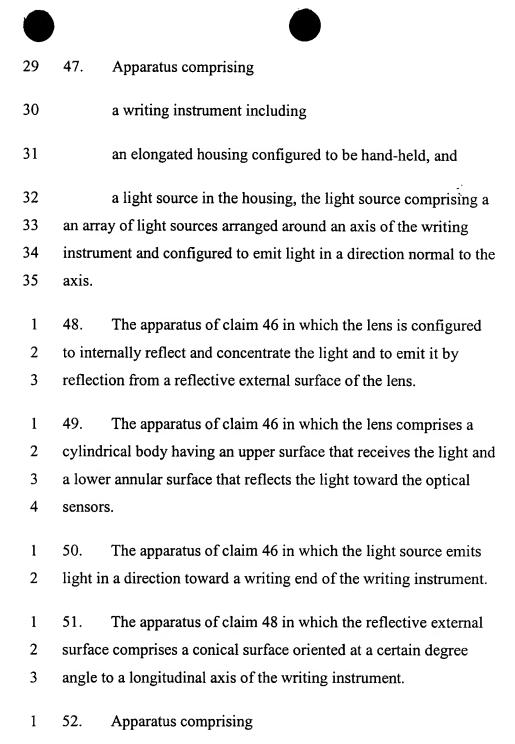


- 25 the writing instrument.
- 26 33. The apparatus of claim 32 in which the processes determine
- 27 the integral power of the overall signal distribution on the sensor
- and calculate a subpixel position based on half of the integral
- 29 power position.
- 30 34. The apparatus of claim 32 in which the processes use a
- 31 polynomial approximation on the signal distribution and calculate
- a subpixel position as a position of approximated maximum.
- 33 35. The apparatus of claim 34 also including a calibration
- procedure to produce parameters to be used in combination with
- 35 data from the sensors.
- 36 36. The apparatus of claim 35 in which the calibration
- parameters correct for non linearity of our sensors, and the
- 38 algorithmic processes use a quasi triangulation technique to
- 39 determine a position of the writing instrument.
- 40 37. The apparatus of Claim 36 in which the calibration
- 41 parameters correct for non linearity of our sensors and the
- 42 algorithmic processes determine the position of the writing
- instrument using polynomial series, when coefficients in these
- polynomials are determined during the calibration procedure.
- 45 38. A method comprising

46	receiving light from a moving writing instrument at an		
47	array of sensing elements of a sensor,		
48	reading the sensing elements in sequence to generate a		
49	sequence of signals indicative of light sensed by the elements of		
50	the array, and		
51	resetting each elements after it is read and before at least		
52	some of the other elements in the array are read.		
1	The method of claim 38 in which the array comprises a		
2	CMOS or CCD position sensor.		
2	CIVIOS OF CCD position sensor.		
1	40. The method of claim 38 in which each of the elements is		
2	reset before the next element in the sequence is read.		
1	41. The method of claim 38 in which all of the elements are		
2	read before all of the elements are reset.		
3			
J			
1	42. A method comprising		
2	conveying light from a moving hand-held instrument,		
3	sensing the light at two or more sensors, each of the two or		
4	more sensors comprising a two-dimensional array of sensing		
5	elements,		
6	generating signals representing the two-dimensional		
7	locations on the arrays of light that is sensed, and Attorney Docket 11627-00200		

8		determining a sequence of three-dimensional positions of
9	the mo	ving writing instrument based on the signals.
10	43.	Apparatus comprising
11		a writing instrument system that can track three-
12	dimens	sional motion of the writing instrument.
13	44.	The apparatus of claim 43 in which the system includes
14	sensor	s having 3 linear arrays.
15	45.	The apparatus of claim 43 in which the system includes
16	sensor	s that are a two-dimensional array or a one-dimensional
17	array.	
18	46.	Apparatus comprising
19		a writing instrument including
20		an elongated housing configured to be hand-held,
21		a light source in the housing, and
22		a lens in the housing configured to receive light
23		from the light source and convey the light through a free-air
24		path to optical sensors spaced from the writing instrument,
25		the lens being configured to enable light to be directed
26		parallel to the writing surface no matter what the
27		orientation or position of the writing instrument to the
28		writing surface.

2



Attorney Docket 11627-002001

a writing instrument including

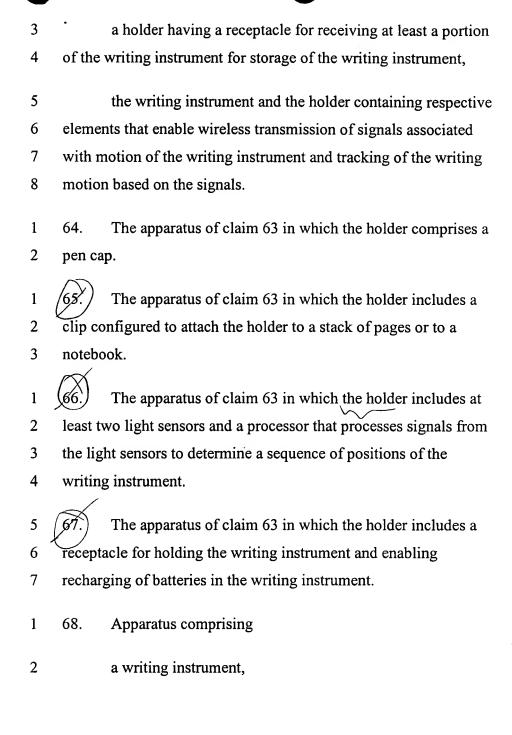
3	an elongated housing configured to be hand-held,		
4	and		
5	a light source in the housing, the light source being		
6	arranged to emit light in a direction parallel to a		
7	longitudinal axis of the writing instrument.		
1	The apparatus of claim 52 in which the light source		
2	comprises one or more LEDs.		
1	54. The apparatus of claim 52 in which the light source		
2	comprises a ring of light sources.		
1	55. Apparatus comprising		
2	a writing instrument,		
3	a light-source in the writing instrument configured to		
4	convey light to sensors spaced from the writing instrument, and		
5	a device configured to turn the light source on and off in		
6	response to a user applying pressure from the writing instrument to		
7	a writing surface, the switch being configured so that an amount of		
8	pressure required to trigger the switch is not so large as to disrupt		
9	normal writing motion of the writing instrument on the writing		
10	surface.		
1	56. The apparatus of claim 55 in which the writing instrument		
2	includes a ballpoint cartridge having a writing point and the device		

- 3 is positioned at the opposite end of the cartridge from the writing
- 4 point.
- 5 57. The apparatus of claim 56 in which the device could
- 6 comprise a switch.
- 7 58. The apparatus of claim 56 in which the device could
- 8 comprise a pressure sensor.
- 1 59. A method comprising
- 2 sending light from a moving writing instrument, the light
- 3 being indicative of a position and path of the writing instrument,
- 4 and
- 5 directly sensing, at one or more sensors spaced from the
- 6 writing instrument, angles from which light is received from the
- 7 writing instrument.
- 1 60. The method of claim 59 in which the angles are directly
- 2 sensed by an array of sensitive elements of a sensing device.
- 1 61. The method of claim 60 in which the sensing device
- 2 comprises a CMOS or CCD device.
- 1 62. The method of claim 60 in which the sensing device
- 2 comprises a PSD.



Apparatus comprising

2 a writing instrument, and



3	an element that enables wireless transmission of a signal
4	associated with motion of the writing instrument and tracking of
5	the writing motion based on the signal,
6	the element being built into a cell phone, a PDA, a webpad,
7	or a clipboard.
1	69. Apparatus comprising
2	two optical sensors separated by a known distance and
3	arranged to
4	receive light from a source associated with a writing
5	instrument,
6	determine directions from which the light is
	determine directions from which the light is
7	received relative to a known direction,
8	provide signals representing the directions for use in
9	determining a sequence of locations of the writing
10	instrument,
11	at least one of the two sensors comprising a CMOS
12	of CCD array.
1	The apparatus of claim 69 in which the CMOS or CCD
2	array comprises a linear array of sensor elements.
1	71. The apparatus of claim 69 in which the CMOS or CCD
2	array comprises a two-dimensional array of sensor elements.
	Attorney Docket 11627-002001

1	72 Apparatus comprising
2	a holder for a writing instrument,
3	the holder having elements used in wireless transmission of
4	signals associated with motion of a writing instrument in the
5	vicinity of the holder,
6	the holder having a mechanism for attaching the holder to a
7	writing substrate in an orientation that enables the elements to be
8	used in conjunction with the wireless transmission.
1	The apparatus of claim 72 in which the clipping mechanism
2	includes a switch to activate functions of a processor in the holder
3	when the clipping mechanism is manipulated.
1	The apparatus of claim 72 in which one of the functions
2	comprises a new page function.
1	75 Apparatus comprising
2	a holder for a writing instrument,
3	the writing instrument including electronic circuitry
4	configured to be used in conjunction with tracking writing motion
5	of the writing instrument, the writing instrument including a
6	rechargeable battery connected to power the electronic circuitry,
7	the holder including a receptacle for the writing instrument
8	and a recharging circuit connected to recharge the battery when the
9	writing instrument is in the receptacle.
1	76. Apparatus comprising

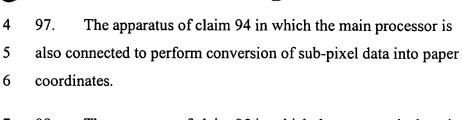
2	a CMOS sensor adapted to receive light associated with
3	motion of a writing instrument and to provide signals indicative of

- 4 an angle of receipt of the light with respect to a known direction,
- 5 and
- a lens aligned to direct the received light to the CMOS
- 7 array.
- 1 (77) The apparatus of claim 76 in which the lens comprises a
- 2 half-ball lens.
- 1 78. The apparatus of claim 76 in which the lens comprises an
- 2 aspherical lens.
- The apparatus of claim 76 in which the lens is optimized
- 4 for collection of light from an area in which the motion of the
- 5 writing instrument occurs.
- 1 80. The apparatus of claim 76 in which the lens comprises a
- 2 flat field lens.
- 1 81. The apparatus of claim 76 in which the lens comprises a
- 2 Fresnel lens.
- 3 (82) The apparatus of claim 76 in which the lens system is
- 4 configured to collect light in a dimension normal to a plane of
- 5 motion of the writing instrument and to project the light onto the
- 6 sensor in a direction parallel to the plane of motion.
- 7 83. A method comprising

8		positioning a writing instrument at a succession of positions		
9	on a wr	iting surface,		
10		generating signals at sensors from light received from the		
11	writing	instruments at the succession of positions, and		
12		determining calibration parameters for the writing		
13	instrum	instrument for use in calibrating a process that determines the		
14	position	positions of the writing instrument as it is being moved.		
15	84.	The method of claim 83 in which the calibration parameters		
16	comprise coefficients used in polynomial series that are part of the			
17	position	n determining process.		
18	85.	The method of claim 83 in which the positions do not lie on		
19	a regula	ar rectangular grid.		
20	86.	The method of claim 83 in which (I need help in reciting		
21	the pseudo geometrical concept.)			
22				
1	87.	A method comprising		
2	į	identifying locations on a writing surface that correspond to		
3	input el	ements to be entered into an electronic device, the writing		
4	surface	being non-electronic and separate from the electronic		
5	device,			

- using a writing instrument to point to selected ones of the identified locations corresponding to input elements to be entered, and
- 9 sensing the locations at which the writing instrument is
- 10 pointing and entering the corresponding data into the electronic
- 11 device.
- 1 88. The method of claim 87 in which the writing surface
- 2 includes a sheet of paper.
- 1 89. The method of claim 87 in which the input elements
- 2 comprise characters of language.
- 1 90. The method of claim 87 in which the input elements
- 2 comprise commands.
- 1 91. The method of claim 87 in which the input elements are
- 2 printed on the writing surface.
- 1 92. A method comprising
- 2 moving a writing instrument across a non-electronic
- 3 writing surface to indicate a path, and
- 4 remotely sensing the path and generating signals for use in
- 5 entering the path into an electronic device that is separate from the
- 6 writing surface.
- 1 93. A method comprising

2		modulating light that is conveyed from a moving writing		
3	instrument to light sensors spaced from the writing instrument at a			
4	prede	predetermined frequency, and		
5		using a phase locked loop associated with the sensors to		
6	lock o	onto the phase of the modulated light.		
1	94.	Apparatus comprising		
2		circuitry for tracking writing motion of a writing instrument		
3	using wireless transmission of signals between the writing			
4	instrument and a stationary element, the stationary element			
5	including a main processor and a separate preprocessor,			
6		the preprocessor being connected to perform at least data		
7	captu	re with respect to motion of the writing instrument,		
8		the main processor being connected to perform at least data		
9	communication with respect to the tracking.			
1	95.	The apparatus of claim 94 in which the preprocessor is also		
2	conne	ected to perform user interface functions and sub-pixel data		
3	storag	ge.		
1	96.	The apparatus of claim 94 in which the main processor is		
2	also c	onnected to perform background cancellation and sub-pixel		
3	calculation.			
3	caicul	аноп.		



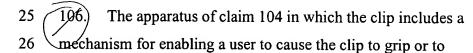
7 98. The apparatus of claim 95 in which data storage is done in

8 the form of paper coordinates.

9

- 1 99. Apparatus comprising
- 2 a writing instrument and a sensor,
- 3 the writing instrument including a reflective element
- 4 configured to reflect light received from outside of the writing
- 5 instrument to the sensor for use in tracking motion of the writing
- 6 instrument.
- 1 100. The apparatus of claim 99 also including a mechanism to
- 2 enable the reflective element to reflect the light to the sensor when
- 3 the writing instrument is being used for writing and to disable the
- 4 reflective element from reflecting light to the sensor when the
- 5 writing instrument is not being used for writing.
- 1 101. A method comprising
- 2 receiving light from a moving writing instrument at a light
- 3 sensor having an array of sensitive pixel elements,

4	determining the location in the array at which the		
5	maximum intensity of light has been received from the writing		
6	instrument, the location being determined with sub-pixel accu	racy.	
7 8	The method of claim 101 in which the sub-pixel locati determined by	on is	
9 10	determining the integer pixel location that is closest to subpixel location, and	the	
11 12	finding a fractional center of gravity of a subarray that centered on the integer pixel location.	is	
13	103. A method comprising		
14 15	indicating locations on a non-electronic surface that correspond to inputs to an electronic device,		
16 17	detecting the locations and inputting them into the electronic device.		
18	104. Apparatus comprising		
19	a sensor configured to detect light from a moving writing	ing	
20	instrument, and		
21 22	a clip for clipping paper on which the writing instrume to be moved to the sensor.	ent is	
23 24	105. The apparatus of claim 104 in which the mechanism comprises part of a clipboard or a notebook. Attorney Docket 11627-0	002001	



- 27 release the paper.
- 28 (10). The apparatus of claim 106 in in which the mechanism
- 29 comprises an activation button and a spring.
- 30 (108). The apparatus of claim 107 in which the mechanism
- 31 includes a lever operated by the button.
- 32 109. The apparatus of claim 108 in which the lever is configured
- 33 to rotate in response to the button.
- 34 (110). The apparatus of claim 107 in which the button is
- 35 configured to be pushed.
- 36 111. The apparatus of claim 107 in which the button is
- 37 configured to be pulled.
- 38 112. The apparatus of claim 46 in which a light guide delivers
- 39 light to the tip of the pen and conveys it outwardly in a disk-like
- 40 pattern.

A-1